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THE IOWAN DRIFT

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INTRODUCTION

Is there an Iowan drift? Whatever the reader may think about it, the question seems to be in order. Three papers have recently appeared in which the Iowan drift receives more or less attention.¹ Two of the papers go so far as to question the very existence of such a sheet of drift as that which geologists have for

¹ Frank Leverett, "Weathering and Erosion as Time Measures," *American Journal of Science*, XXVII, May, 1909.

——, "Comparison of North American and European Glacial Deposits," *Zeitschrift für Gletscherkunde*, IV, Berlin, 1910.

T. C. Chamberlin, "'Comparison of North American and European Glacial Deposits,' by Frank Leverett;" a review of the second paper, *Journal of Geology*, XVIII, No. 5, July-August, 1910.

some time been calling Iowan. The third paper raises the question whether, even if there is such a drift, the name it has been wearing should not be applied to something else. It is possible that the questions raised by these papers may never be settled to the satisfaction of everyone, because men do not always see alike; but a few facts bearing on the subject may be worthy of consideration.

CAUSE OF CONFUSION IN USE OF THE TERMS KANSAN AND IOWAN

The doubt as to the correct use of the terms Kansan and Iowan is the one that deserves first and most serious attention. This doubt has arisen naturally and for admittedly good reasons, but it is all due to the fact that in the earlier discussions of the Pleistocene deposits of northeastern Iowa it was assumed that there were but two drift sheets east of the Wisconsin lobe which occupies the north-central part of the state. The two supposed drifts were named by McGee¹ the Upper and the Lower till. The view that there are but two tills in this area was adopted by Chamberlin in his classic contribution to the third edition of *The Great Ice Age*, by James Geikie,² and the name East-Iowan was given to what was assumed to be McGee's Upper till, while what was taken to be the Lower till was called Kansan. There are, however, three drift sheets in the region, and the attempts to describe three formations in terms of two led to confusion. In some cases the upper and middle sheets were described as a unit; in others the lower and middle were treated as one; much more frequently the lowest was ignored, and the descriptions of the "lower" and "upper" tills were drawn from the other two. The presence in certain localities of a forest bed or interglacial gravels, which it was assumed always lay between what the authors described as upper and lower tills, as East-Iowan and Kansan, complicated matters still further. There are, indeed, many positive references in the original texts to this forest and gravel horizon—since called Aftonian—as the plane of separation between the two drift sheets

¹ Paper on "The Pleistocene History of Northeastern Iowa," by W J McGee, *Eleventh Annual Report of the United States Geological Survey*, Part I, 1891, pp. 189-577; and other papers by the same author.

² *The Great Ice Age*, 3d ed., chaps. xli and xlii, "Glacial Phenomena of North America," by Professor T. C. Chamberlin, pp. 724-74, 1895.

at that time credited to the region; but if the texts relating to the subject are carefully read and the maps published in connection with them are examined, it will be seen that the view that the lower till, the Kansan, lies below the Aftonian is untenable. For example, the description of the materials and prevailing color of the upper till on p. 476 of the *Eleventh Annual Report* is true for only the third of the drift sheets and is at variance with the facts if intended to include the middle till. The same is true of the reference to the large granite bowlders as "the most conspicuous element of the upper till," on p. 481. On the other hand, the characteristics assigned to the lower till in the comparisons made between it and the upper on p. 479, are all features that belong to the middle drift sheet; in no true sense are they descriptive of the sub-Aftonian. It is true that at the end of the paragraph there is a reference to the "forest bed" as a plane of separation between the upper and lower tills, but the characters which the author saw and so correctly and graphically described belong to a super-Aftonian till and to nothing else.

If now we turn to the chapters on "Glacial Phenomena of North America," contributed by Professor Chamberlin to Geikie's *Great Ice Age*, we shall see again how the preconception that there were but two drifts where three actually exist, led unavoidably to confusion. It is no reflection on anyone that such confusion crept in in the earlier discussions. Some things are unavoidably overlooked by the pioneer who opens up for us new fields of science, and we can but admire the genius and the insight of the masters who taught us how to read the complicated history of the Pleistocene deposits of the Mississippi Valley. As in the *Eleventh Annual Report*, so in the *Great Ice Age*, it is two super-Aftonian tills that are most frequently referred to in the text, and most accurately represented on the map opposite p. 727 as, East-Iowan and Kansan. The distinguishing characteristics of the upper and middle drift sheets could not be more clearly or more succinctly stated than is done on p. 760 of the work cited where, speaking of the East-Iowan, it is said:

In Iowa the granitic types predominate. Immense bowlders are freely scattered over a portion of the surface. As greenstones prevail in the lower

till, there is a petrological as well as a stratigraphical basis for separating the two formations. . . .

The most notable feature of this drift sheet is its connection with the main deposits of loess. . . . The East-Iowan till sheet is, however, associated with loess of such exceptional extent and nature as to make this epoch especially notable on account of this relationship. As already stated, the till graduates at its edge into loess that spreads away from its border.

The statements quoted can be interpreted in but one way. They are true in case the term East-Iowan was applied to the uppermost of the three till sheets in Iowa east of the Wisconsin moraine. There is just one till in which "granitic types predominate." There is just one of which it can be said that "immense boulders are freely scattered over a portion of the surface." There is just one that bears the described relation to the loess. While greenstones occur in all three of the till sheets of the area under consideration, it is in the middle sheet that they are most conspicuously prevalent.

The statement on p. 756 of *The Great Ice Age*, clearly implied if indirectly made, that "the Kansan formation emerges from beneath the overlapping East-Iowan formation to the extent of 200 miles at the west" can apply only to a sub-Iowan, but super-Aftonian drift. It cannot possibly apply to the sub-Aftonian for the reason that at the time it was written the known natural exposures of the sub-Aftonian were confined to a very limited area. A number of outcrops of this formation have since been recognized and recorded, but it may be questioned whether the aggregate of all the now known exposures of sub-Aftonian would be equal to more than one or two square miles. Certainly there are no known areas of anything approaching 200 miles in extent in which the lowest of our drift sheets emerges from beneath anything so as to justify its representation on a map. Other statements that can apply only to what geologists have recently and consistently been calling Kansan occur on p. 757. The Kansan, we are told, "is greatly worn in regions where the denuding agents have worked under favorable conditions. . . . In other regions of flat surface and low declivity the degradation is less marked, and extensive remnants of the original surface-plane have been preserved." The first super-Aftonian drift fulfils the conditions of the parts of the text quoted and of many others; the sub-Aftonian does not.

While admitting, then, all that may be claimed for the frequent references to the Aftonian soils, forests, peats, and gravels, it must also be admitted that the descriptions in the early texts, which treat of the texture, color, and petrological contents of the Kansan and the Iowan, are based on observations made on two super-Aftonian drifts. If there could remain a particle of doubt on this point after reading the texts, the doubt would be dispelled by an examination of the map opposite p. 727 of *The Great Ice Age*. The drifts of the two areas represented as Kansan and Iowan respectively are both super-Aftonian, and, considering the state of knowledge at the time, the map is remarkably correct. The eastern edge of the Iowan could scarcely be better drawn today. With the exception of a few points which would be mere microscopic dots on a map of this scale, the whole area mapped as Kansan is covered with super-Aftonian till. There is not a single known natural outcrop of sub-Aftonian in the Kansan area east of the Iowan margin. There are no known outcrops of sub-Aftonian in Illinois, Missouri, or northeastern Kansas where the map shows extensive areas of Kansan. It is only very recently that the presence of sub-Aftonian has been demonstrated in Nebraska; but even here it occurs in vertical sections at the base of bluffs, in such position that it could not well be represented on maps of moderate size. In Nebraska, as in practically all the rest of the area mapped as Kansan, it is a super-Aftonian drift that occupies the Kansan area on the map. In all the earlier texts and maps it is a super-Aftonian drift to which the name Kansan was most persistently and most consistently applied.

EFFECTS ON TEXTS AND MAPS OF MAKING CERTAIN PROPOSED
CHANGES IN THE USE OF THE TERMS KANSAN AND IOWAN

As has been said, the imperfection of knowledge at the time the Iowan and Kansan drifts were named led to confusion and inconsistencies of statements, and these are of such character and extent as to make it now utterly impossible to apply the proposed names in any conceivable way that will be in full accord with all the statements of the texts. The frequent and positive references to the horizon of the gravels and forest beds must be admitted and must be given full weight in determining the particular drift sheets to

which the names Kansan and Iowan should be applied. On the other hand, the original descriptions of the lower and upper till—of the Kansan and the Iowan—must have careful consideration, and the evidence of the map in *The Great Ice Age*, above cited, must be taken into account. The descriptions would have to be rewritten and the map redrawn to make them consistent with the view that the Kansan is sub-Aftonian. If the term Kansan is transferred to the sub-Aftonian, and the term Iowan to the drift next above,¹ practically the whole area represented on the map as Kansan would have to be changed to Iowan. The Iowan would then extend into southern Illinois, would cover southern and western Iowa, northern Missouri, eastern Nebraska, and northeastern Kansas. With the transfer of the term to the sub-Aftonian the Kansan would be represented on the map by a few dots and thin lines that could be seen only with the magnifier, the whole area comprising an aggregate of only a few sections; and in the present state of knowledge we could not be certain that Kansas has a cubic foot of Kansan (sub-Aftonian) drift. We are face to face with the fact that any application of the terms Kansan and Iowan involves some inconsistencies, is at variance with some of the statements in the original publications; and so long as we seem to need the terms and have to use them, it is only a question of how to use and apply them so as to do least violence to the original maps and descriptions. If the map and descriptive texts referred to may be taken as representing the intent of the authors, the practice of applying the terms which has been followed, and which seems now to come in for a certain amount of mild condemnation, is the only one that is reasonably consistent or possible. For it must be admitted that if the sub-Aftonian is to be called Kansan, and the first super-Aftonian drift is to be the Iowan, more than nine-tenths of the original descriptions are wholly erroneous and misleading, and the map in *The Great Ice Age* showing the distribution of these drifts is altogether meaningless and at variance with the facts. Recent usage in the application of the terms Kansan and Iowan is based on what seemed to be, and still seems to be, the only reason-

¹ Some such shift as this seems to be favored by what is said in the *Journal of Geology*, July-August, 1910, pp. 473-74.

able interpretation of what the authors had in mind when describing the physical characteristics of the two drift sheets and mapping their areal distribution. A departure from this usage, which would make the sub-Aftonian till Kansan and would apply the term Iowan to the old, weathered till above the Aftonian, with its blue color, its strikingly conspicuous array of greenstones, and with relations to the loess so entirely different from the relations correctly described in the text as pertaining to the Iowan, would necessitate the making of radical and revolutionary changes in the map and descriptive texts above noted. It surely accords better with what was published at the time the names were applied to let recent usage remain unchallenged and unchanged.

EVIDENCE CONCERNING THE IOWAN DRIFT AND ITS GEOLOGICAL RELATIONS

The surprising attitude toward the Iowan drift, expressed in the papers by Leverett, is something difficult to understand. A very little field study in the right places will demonstrate:

1. The Iowan drift is.
2. The Iowan drift is young as compared with the Kansan.
3. The Iowan drift is not a phase of the Kansan.
4. The Iowan drift has very intimate relations to certain bodies of loess.
5. The Iowan drift is not related to the Illinoian.

THE IOWAN DRIFT IS

To discuss the question of whether there is an Iowan drift distinct from the super-Aftonian till that has been called Kansan is like undertaking a task that one knows is absolutely useless and unnecessary. For, while the Iowan is thin, and in places is absent, there is here a very substantial drift sheet overlying the Kansan and possessing distinctive characters of its own. The Iowan is separated from the Kansan by a ferretto zone in some places and by weathered gravels in others, while its characteristic topography and remarkable boulders proclaim its presence throughout extensive areas where no sections are available. Buchanan gravels, distributed by volumes of water from the melting Kansan glaciers,

and disposed in numerous sheets and ridges, were laid down throughout northeastern Iowa, on top of the Kansan till, over the area which, but a short time previously, had been abandoned by the retreating ice. They are true outwash gravels. Exposure during the long interval between the Kansan and the Iowan has wrought profound changes in the decomposable granites and other

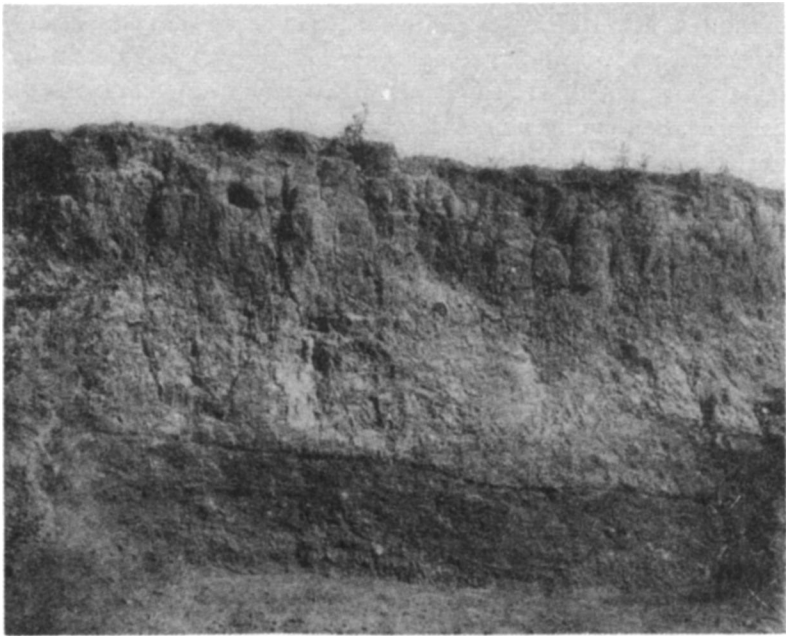


FIG. 1.—View in the old gravel pit near Doris, Buchanan County, Iowa, showing Buchanan gravels, a deposit contemporaneous with the closing phase of the Kansan, overlain by the younger Iowan drift.

constituents of the Buchanan deposits; and now these gravel deposits become unimpeachable witnesses to the fact that glaciers belonging to a stage long subsequent to the Kansan distributed a new sheet of till differing from the Kansan in composition, color, and petrological contents. The Iowan is yellow; the Kansan, while normally blue, sometimes weathers yellow; where yellow Iowan rests directly on yellow weathered Kansan, the line of contact may not be as distinct and satisfactory as some observers

might wish; but where the Buchanan gravels intervene, the fact that there is a drift younger than the Kansan and perfectly distinct from it is as clearly indicated as that there are two drifts separated by the Aftonian horizon.

Leaving out, therefore, all the evidence from the multitudes of well sections and all other natural or artificial exposures that do not show the intervening aqueous deposits, a few of the scores of points where a young till overlies super-Kansan gravels may be



FIG. 2.—View in the same pit a few rods west of point shown in Fig. 1, taken while work of excavation was in progress, showing the uneven line of contact between the old gravels and the younger, overlying Iowan. The irregularity in the contact line may be due to plowing or gouging by the Iowan ice.

cited. The best-known of these is the old Illinois Central gravel pit near Doris in Buchanan County, a point that has been frequently mentioned. Here are gravel beds with a maximum thickness of fifteen feet or more. The deposit furnished many hundreds of carloads of railway ballast annually for a number of years. In the central part of the pit the gravel was taken out down to the blue Kansan till, and balls of the same blue till are included in the deposit. At the east end of the excavation there are at least ten feet of yellow till above the gravel, recording a later, newer stage of glaciation. The thickness of the later deposit is variable, for it

was laid down on an uneven surface; but at the point illustrated in Fig. 1, the section of the till, including the black loam at the top, is about eight feet. That the later and newer till is unconformable on the gravel is shown in Fig. 2. The typical bowlders of the Iowan drift belong to this overlying till; there is nothing corresponding to them in the blue Kansan. In the process of excavation a number of the Iowan bowlders were undermined and allowed to fall into the pit. One such, perched on the brink of the excavation, is shown in Fig. 3, and a larger-sized companion, completely undermined, has fallen in. The typical, young, uneroded, boulder-dotted surface of the younger drift, which stretches away from the margin of the old working, is illustrated in Fig. 4.

A quotation or two from the report on Buchanan County, *Iowa Geological Survey*, VIII, may be pertinent. On pp. 239-40 we read:

A very common relation of Pleistocene deposits is illustrated in the well section on the land of J. W. Welch in the southwest quarter of Section 28, Buffalo Township. The record shows:

	Feet
3. Dark soil and yellow till.	4
2. Reddish, ferruginous sand and gravel.	23
1. Blue clay, penetrated.	1

No. 3 of this section is Iowan drift, No. 2 is Buchanan gravel, and No. 1 is Kansan till.¹ In the same quarter section another well shows,

	Feet
3. Soil and yellow till.	22
2. Reddish gravel.	11
1. Blue clay, with pockets of sand.	19

Although the thickness varies considerably, the members of this last section are severally the same as the corresponding numbers of the one above.

In another part of the same report, p. 209, it is recorded that "the eastern part of Fairbank Township is a very level, dry plateau in which a sheet of Iowan drift varying from two or three to thirty feet in thickness overlies an extensive bed of Buchanan gravels. The plateau is a unique piece of prairie land, without the usual undulations, and without any indications of imperfect drainage. The underlying gravel seems to afford an easy means of escape for the surplus surface waters."

¹ Owing to an error in proofreading the terms Iowan and Kansan are transposed on p. 240 of the volume cited.

Many similar cases could be cited, but it surely is not necessary to multiply arguments in support of a fact that is so perfectly obvious as the existence of the Iowan drift (Figs. 1 and 2). There is no sheet of till that has more distinctive characters, more definite stratigraphic relations. A glacial deposit showing thicknesses of 4 feet, 10 feet, 22 feet, 30 feet, a deposit with distinctive boulders of enormous size, a deposit that is young, fresh, uneroded, and separated from the Kansan by a weathered ferretto zone and profoundly altered gravels, is certainly a very real and substantial



FIG. 3.—View in the Doris gravel pit, showing undermined Iowan boulders, one is still perched on the brink of the excavation; the larger companion has fallen into the pit.

thing that may not be disposed of by referring to it as “only the weathered surface of a drift,” or by the use of such a qualifying phrase as “so-called Iowan.”

That there are two gravel horizons in this region—one Aftonian, the other Buchanan, one below the blue Kansan drift, the other above it—is indicated by two wells near the northwest corner of Section 22, Buffalo Township, Buchanan County. One of the wells, 152 feet deep and ending in gravel (Aftonian) which lies beneath the Kansan, furnishes a constant stream of water an inch in diameter; the other, which is not flowing, is 25 feet deep and ends in a bed of Buchanan gravel which overlies Kansan.

From the other counties included in the Iowan area comes evidence of the distinctive character of the Iowan drift similar to the evidence from Buchanan. Probably the banner county in Iowa for inter-Kansan-Iowan gravels is Floyd. Here are scores of exposures, occupying every conceivable position from the flood plains of the streams, like the Little Cedar, the Cedar, and Flood creeks, which carried off the waters from the melting Kansan ice, to the highest points on the broad, monotonously level, uneroded divides; and in every case within the Iowan area where these old, weathered gravels are known to be present; they are overlain by deposits indicating a much later and newer glacial episode. It will be sufficient to note only a few of the numerous cases which have been observed. At the old brickyard west of the fair-ground in Charles City the material used was a five-foot bed of loam and yellow clay carrying Iowan boulders four to five feet in diameter, and overlying the valley phase of the Buchanan gravels, which, in the neighborhood of Charles City, attain an enormous development. For some miles above Charles City, on the west side of the Cedar River, the old valley gravels may be seen passing under a thin bed of young, boulder-bearing loam and clay which covers the gentle slopes and passes up over the flat divides. A boring with a post auger within the boulder-strewn area went through the thin edge of the Iowan loam into the underlying gravels. The holes dug for some recently set telephone poles along the road and a small stream trench some distance up the slope in the field show the same relation of boulder-bearing loam to the Buchanan beds. A young glacial deposit overlies super-Kansan gravels; at one point in the trench the gravels rest on the blue Kansan till.

The same story is told, though in a slightly different way, by the majority of the many "mound springs" of this part of Iowa. Mound springs are peaty, boggy places on the hill slopes, due in most cases to the presence of upland gravels lying on impervious blue Kansan, and all covered by the younger sheet of Iowan. The gravels in such cases are reservoirs holding large quantities of water, and this escapes on the slopes near the plane of contact between the reservoir and the underlying clay at the point where the conditions are most favorable, presumably where the Iowan cover is

thinnest. The dry upland slopes above the level of the peat, as well as the dry slopes below that level, are liberally sprinkled with Iowan boulders imbedded in loam and clay and ranging up to more than 12 feet in diameter. These boulders are in themselves adequate evidence of a glacial invasion at a time subsequent to the gravel-forming phase, for they were not transported and deposited by either wind or water.



FIG. 4.—View looking north from the margin of the Doris pit, showing the young, uneroded, boulder-strewn Iowan drift plain; a very typical view in the area occupied by this young drift.

Typical examples of mound springs, easily accessible from Charles City, and showing the stratigraphic relations of Kansan, Buchanan, and Iowan deposits, occur on both sides of the railway in the north half of Section 2, Township 95, Range 15. Preliminary to laying a water pipe from the springy belt to the barn on the land of Mr. W. E. Waller, south of the railway, a shallow well was dug on the dry ground just above the peat; and this passed through the cover of Iowan boulder-bearing loam and clay, and through the thinned edge of the rusty gravels, down far enough to make a water-tight basin in the blue Kansan. A deeper well near the barn, with 12 feet of gravel and 60 feet of blue clay, may be cited

to show the constant relation of the prevailing gravels of the region to the typical Kansan drift. The same relation is shown in the fine Pleistocene section which occurs a few rods north of the Mitchell County line, not far from the southwest corner of Section 14, Township 97, Range 17. Here, in the south bank of Rock Creek, is an exposure of typical Kansan, blue in color and breaking into the characteristic polyhedral blocks, with an exposed thickness of 50 feet; at the top is a discolored, weathered zone three to four feet thick; next in order is a gravel bed, rusted and rotted, thickness about two feet; and all is covered by a thin loamy deposit carrying many fresh boulders of varying size, belonging to a post-Buchanan stage of glaciation—the Iowan.

. But it is certainly unnecessary to offer additional evidence along this line. Cases of the kind already cited may be multiplied indefinitely. Fortunately the Buchanan gravels are especially well developed in northeastern Iowa, and in the Iowan area they uniformly afford indubitable evidence of a younger, newer, later stage of ice invasion. Outside the Iowan area, as at Colesburg, Delaware County, on the east, and at Iowa City on the south, the Buchanan gravels are covered with heavy deposits of loess, and without the least suggestion of later glaciation. Some very important event, later than the deposition of the gravels, an event which caused the deposition of a body of till ranging up to 20 or 30 feet in thickness and carrying boulders more than 12 feet in diameter, occurred within the Iowan area and did not occur outside of it. What was that event? Observations in and around the area lead unavoidably to but one conclusion, a conclusion that admits of no question:

The Iowan drift is.

THE IOWAN DRIFT IS YOUNG AS COMPARED WITH THE KANSAN

The superposition of the Iowan till and the great Iowan boulders on the weathered Buchanan is all the evidence needed to demonstrate that the Iowan is younger than the Kansan. The freshness of the granites in and on the Iowan—many with the sharp angles caused by fracture unaffected by weathering (Fig. 10), while the granites of the Buchanan are very largely in an advanced stage of

decomposition—lends strong support to the view that the Iowan is separated from the Kansan by a very long interval of time.

The relative youth of the Iowan may, or may not, be indicated by the fact that in places the formation is still very calcareous up to the grass roots.. A concrete illustration of calcareous Iowan is seen in a shallow well near the northwest corner of the southeast quarter of Section 21, Township 95, Range 17. It should be stated

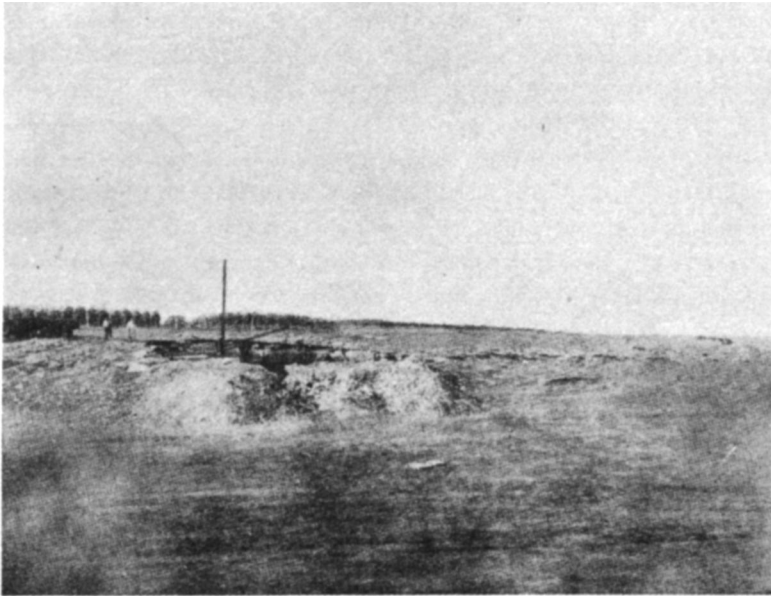


FIG. 5.—View at the Dykeman quarry in Section 26, Township 97, Range 17, showing part of an area of thin drift, in which neither Iowan, Kansan, nor Nebraskan can be recognized.

that the later investigations show that this young drift is variable as to the amount of the lime content; for in such localities as that just cited it seems to be as rich in calcium carbonate as the Wisconsin, while in other places it gives no reaction with acid. The original statement concerning this constituent of the Iowan drift was based on facts which remain true for the localities which had then been tested; but the writer has long since ceased to attach much importance to the acid test as a basis for determining the

relative age of drift. The splendid piece of work by Dr. R. T. Chamberlin in the St. Croix region¹ shows how a very young drift may exhibit no trace of lime, while a much older one may give vigorous reactions. In each and every case the amount of calcium carbonate present at or near the surface of a deposit of drift will depend on the original composition of the till and the movements of the ground waters. The same drift sheet gives very different reactions in different localities. The work in Taylor County in 1910 showed very large quantities of lime carbonate in the form of segregated sheets and nodules, distributed along the joints in the highly weathered zone of the old Kansan. The lime came practically to the surface and was turned up among the grass roots by the plow. Along the roadsides, where the highway had been recently worked, it was breaking down to powder and mixing with the crumbling clay; and a sample of the old drift taken at the very surface might have given such energetic reactions to the man with the acid bottle as to lead him to think that he was dealing with the youngest glacial deposit in Iowa. Just why it is that both the old Kansan and the young Iowan should be so very calcareous up to the grass roots in some localities, while showing no traces of lime in others, could be explained, in some cases at least, on the basis of physical characteristics and relation to surface and sub-surface drainage; but it will be sufficient here simply to record the fact and repeat the obvious inference that acid tests applied to drift sheets are of exceedingly small importance in the determination of relative age. The acid bottle, intelligently used, has its place; but the user must be careful to recognize its limitations.

Among the evidences of youth in the Iowan drift is the fact that, in its typical areas, it is uneroded and imperfectly drained. The area selected for illustration in Fig. 7 of the article from the *American Journal of Science*, and again in Fig. 5 of the paper reprinted from the *Zeitschrift für Gletscherkunde*, and offered as "the type of erosion" in the Iowan drift or as something "showing topography of a so-called Iowan drift plain," is a somewhat unfortunate and misleading choice for the reason that it is representative of but a

¹ Rollin T. Chamberlin, "Older Drifts in the St. Croix Region," *Journal of Geology*, XVIII, No. 6, September-October, 1910.

small fraction of the real Iowan drift plain. It embraces the headwaters of Otter Creek, the valley of which belongs to one of the numerous small, exceptional areas in which there is no drift of any kind, neither Nebraskan, Kansan, nor Iowan. Within the southern edge of the map, and at Hazelton, less than a mile farther down the valley, the Niagara limestone is exposed in natural cliffs or quarry faces, forming continuous exposures along the streams in Sections



FIG. 6.—View taken east of the diagonal road in Section 28, Township 95, Range 15, showing typical driftless hills in the belt of country west of the Cedar River.

2 and 10 of Hazelton Township. A part of Section 2 is included in the map. There are outcrops below the village of Hazelton; and in the roads on the sloping sides of the valley, up to the summit of the slopes, rain, wash, and wear of traffic have exposed the fossiliferous Niagaran dolomite, so thin and meager is the Pleistocene in this anomalous area. A full discussion of the Niagaran outcrops in this practically driftless valley will be found on pp. 217-20, *Iowa Geological Survey*, VIII, published 1898. Describing one of the quarries in Section 10, the report says: "The height of the

vertical quarry face is about fourteen feet. The upper two or three feet is made up of soil, reddish-brown residual clays, and decayed fragmentary limestone." It will be noted that there is no recognizable drift; and if the area mapped is to be used to prove that there is no Iowan, with equal force, fairness, and cogency certain parts along its southern margin, together with the whole

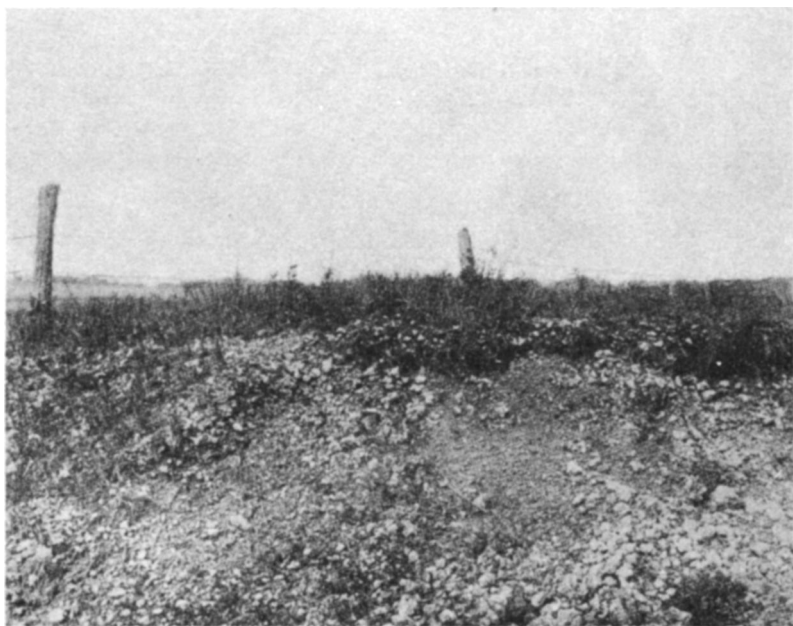


FIG. 7.—View on north side of the road passing through the middle of Section 21, Township 84, Range 18, showing the marly, fossiliferous phase of the Lime Creek shales at the surface, with no overlying drift of any age.

valley of Otter Creek southward, might be used to prove that there are no glacial deposits of any sort within the whole state of Iowa.

It would be possible to select a great many points within the Iowan area, that are driftless or practically so, where Pleistocene deposits are wholly absent or are represented by thin beds of sandy loam or a few stray boulders. One such begins in the eastern edge of Independence and extends eastward over the stony hills for more than a mile. This is part of a belt some miles in length bordering

the Wapsipinicon River. The valley of the Cedar River, the anomalous characteristics of which are recognized and noted, if not explained, in *Iowa Geological Survey*, XIII, 298, 306, affords numerous examples (Figs. 5, 6). For some unaccountable reason the parts of the state occupied by the Lime Creek shales have an unusual number of driftless patches, some of which have dimensions of several miles. A rather small, but typical area of the kind occurs

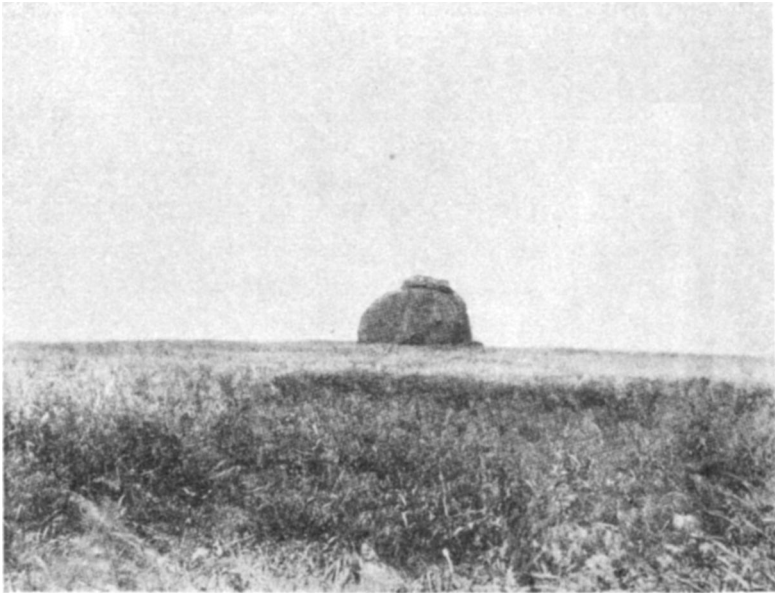


FIG. 8.—View on ridge in Section 3, Washington Township, Chickasaw County, Iowa, showing the largest boulder in the county rising out of a heavy growth of small grain.

in Section 21, Township 84, Range 18 (Fig. 7). Large areas, almost continuous, occur over the ten-mile stretch between Mason City and Rockwell; and on the south side of Lime Creek there is a belt, practically driftless, two or three miles wide, all the way to Rockford. There may be boulders in these areas, even where the other constituents of the drift are absent; and in no small proportion of the territory under consideration, "the soil through which the farmer drives his plow is made up of decomposed shales of

Devonian age." The collector may gather Lime Creek fossils in the pastures and cultivated fields. The peculiarities of these areas, so far as they are seen in Cerro Gordo County, are noted in *Iowa Geological Survey*, VIII, 175, where, years ago, the statement quoted was published.

With the exception of the sub-Aftonian, or Nebraskan, which does not give character anywhere to parts of the glaciated territory large enough for mapping, each drift sheet has its characteristic topography which prevails over the major part of its area, and each has its exceptional phases which affect but a small percentage of its surface. There is a broad belt of typical Iowan between the Wapsipinicon and the Cedar, north of Walker. With the exception of a narrow strip west of the larger river, the broad area between the anomalous Cedar and Flood creeks in Mitchell, Floyd, and Franklin counties is as strikingly level, uneroded, and free from drainage courses as much of the typical Wisconsin, and in some places it is also quite as calcareous. Flood Creek is simply a prairie stream that scarcely breaks the monotony of the plain that extends from the Cedar to the Shell Rock; through its entire course north of Nora Springs, even the Shell Rock flows in a young, shallow trench cut in the otherwise unbroken Iowan plain. Areas such as these—scores of miles in length and width, with scarcely a drainage trench outside the channels of the larger streams—illustrate the real type of erosion in the Iowan; these show the topography of a real Iowan drift plain, and it is scarcely necessary to add that that topography is characteristic of youth.

The typical boulders of the Iowan are coarse feldspathic granites in no way remarkable for their power to resist the destructive agencies of weathering, and yet very little decomposition has taken place amongst them since they were left exposed at the time of the retreating Iowan ice. In some way, either before or during transportation, many of the boulders were fractured, and in such cases the angles are still comparatively sharp (Fig. 10), while boulders of corresponding texture in the Buchanan gravels or in the weathered zone of the Kansan drift are completely decayed. Topography, boulders, and stratigraphic position all unite in support of the theses:

The Iowan drift is young as compared with the Kansan.

The Iowan drift is not a phase (weathered or unweathered) of the Kansan.

The statement on p. 282 of the paper on "Comparison of North American and European Glacial Deposits," to the effect that the Iowan boulders "are found chiefly in shallow draws, called sloughs,



FIG. 9.—View in Section 14, Township 95, Range 16, showing a fresh, planed boulder of the Iowan type in a dry, cultivated field.

at the heads of the valleys or drainage lines," has no special significance even if it were fully justified; but the fact is that the Iowan boulders occur in various relations to the rather featureless topography of the region to which they are confined. The largest mass of granite in Chickasaw County is on the highest ridge of the whole region, midway between Devon and Alta Vista. There are three Iowan boulders in Floyd County especially noted for their commanding size, and each is located on dry upland. One of these (Fig. 10) occurs less than two miles southwest of Charles City, in the northwest quarter of Section 14, Township 95, Range 16. It

lies in a cultivated field on the long gentle slope above the road which follows the north line of the section. The dimensions above ground are $27 \times 21 \times 11$ feet. Some of the faces are surfaces of fracture, and the angles remain sharp and unaffected by weather. A fragment of smaller size, evidently split off from the larger mass during the time of transportation, equally fresh as to angles and



FIG. 10.—View in Section 14, Township 95, Range 16, showing one of the largest and most typical of the Iowan boulders on dry ground, with sharp angles unaffected by weathering.

general surface, lies a few rods to the northeast. A very fine boulder (Fig. 11), more massive than the Charles City specimen, unbroken in transportation, lies near the southeast corner of the city park in Nora Springs, and there are neither “draws” nor “sloughs” anywhere near it. Probably the largest boulder in the state, the largest so far recorded, occurs in a dry pasture near the southwest corner of Section 22, Township 94, Range 15 (Fig. 12). It is more than forty feet in length, a block of characteristic Iowan

granite of royal proportions. In some parts of the Iowan area, notably in the region between the Cedar and Little Cedar east of Charles City, the bowlders are distributed in trains which stretch across the country from northwest to southeast without respect to sloughs, while intervening spaces of essentially the same topography are practically free. The fact is, however, that the bowlders may be anywhere; upland or lowland seems to make no special differ-



FIG. 11.—View in Nora Springs, Iowa, showing a large and very typical Iowan boulder on dry upland, near the southeast corner of the city park.

ence; their distribution follows no constant rule, except one: *typical Iowan bowlders are strictly limited to the area of the Iowan drift.*

THE IOWAN DRIFT HAS CERTAIN VERY INTIMATE RELATIONS TO CERTAIN BODIES OF LOESS

The discussion of the loess and of Calvin's attitude toward it, on pp. 298-99 of the Berlin paper, is based on so many misapprehensions that the task of straightening out the tangle is one too hopeless to be undertaken. There are bodies of loess belonging to different ages, but there is one loess that stands in intimate and close relation to the Iowan drift. The view that the loess is chiefly

an interglacial deposit is in no way inconsistent with the earlier view—and the view still entertained so far as the source of the deposit is concerned—“that the loess is a silt derived from the finer materials of the Iowan drift.” That a certain deposit of loess was derived from the Iowan is a conviction that grows stronger and stronger as the work is prosecuted farther and farther in the

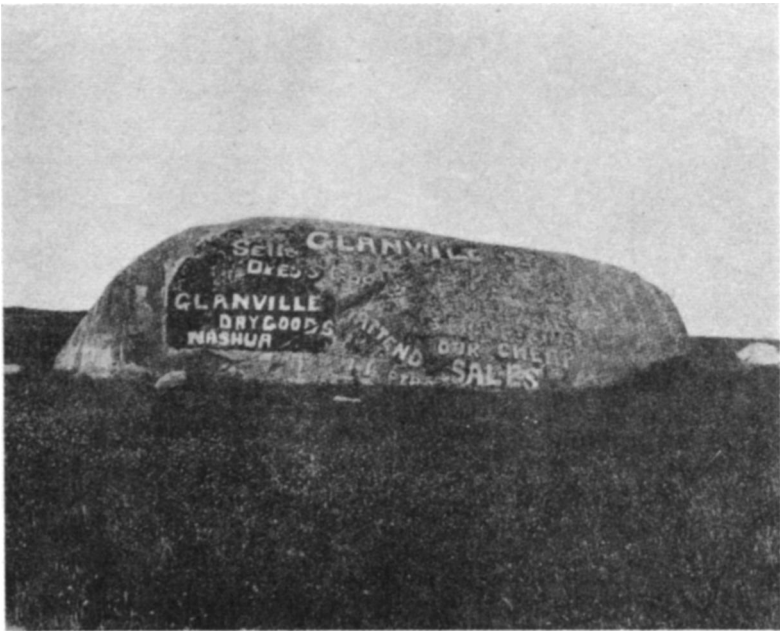


FIG. 12.—View near the southeast corner of Section 22, Township 94, Range 15, showing what is probably the largest Iowan boulder in the state; and this lies in a dry pasture.

field; and outside the paper under consideration there has never been any “abandonment of the view that there is an Iowan drift correlating with the loess.”

The Buchanan gravels are an interglacial deposit. They are not of glacial origin, and they lie between two sheets of drift. The fact that they are interglacial, however, gives no adequate ground to infer that they were not derived from the Kansan, or that there has been an abandonment of the view that there is a Kansan

drift correlating with the Buchanan gravels. The Iowan loess is related to the Iowan drift in much the same way that the gravels are related to the Kansan. The earlier view was that the loess was deposited at the time of maximum development of the Iowan glaciation, when the Iowan area was still covered with ice. The only modification of that view at the present time is that loess deposition took place after the Iowan ice had retreated to a greater or less extent, after an interglacial interval had actually begun. By such retreat extensive mud flats were left, and as these dried before becoming covered with vegetation, strong winds coming, probably, from the ice fields to the north, carried fine sand and dust from the bare surfaces and deposited them beyond the edge of the Iowan area, out upon the old, eroded Kansan. For the development of loess three things seem to be necessary: (1) a gathering-ground of extensive bare and dry surfaces, such as would be furnished by the part of the Iowan area from which the ice had retreated; (2) winds to transport the materials from the dried mud flats; (3) anchorage such as would be furnished most extensively by the vegetation of the extra-marginal Kansan surface. The bare Iowan area afforded no anchorage, but it was an excellent source of supply. Waters carried and sorted materials from the Kansan till and deposited the interglacial formation called Buchanan gravels; winds picked up from the Iowan till such materials as they could transport, and deposited amidst the vegetation of the extra-marginal territory the interglacial formation known as the Iowan loess. The genetic relation of the loess to the Iowan drift is not so very unlike the corresponding relation of the Buchanan gravels to the Kansan; and so far as genetic relationships are concerned, there has been no abandonment of the view originally proposed.

The color, composition, and calcareous content of the Iowan loess are in perfect accord with the hypothesis just expressed; its geographic distribution around the lobed margin of the Iowan area agrees also with the view; the great thickness of this loess at and near its inner margin, and its thinning out with increasing distance from the source of supply, corroborate all the other lines of evidence; while the great amount of eolian sand associated with it in a narrow belt surrounding the lobes of Iowan drift lends additional support.

The Missouri River loess and all other loess deposits which have evidently been derived from the broad flood plains of near-by rivers, have a similar distribution relative to their source; they are thickest and coarsest near the gathering-ground and become thinner as the distance from the base of supply increases. All the facts connected with the origin, composition, and distribution of the loess are perfectly explicable without resorting to the hypothesis that "a considerable part was derived from the great plains east of the Rocky Mountains." Studies in the field afford overwhelming evidence that, genetically and geographically, *the Iowan drift has very intimate relations to certain bodies of loess.*

THE IOWAN DRIFT IS NOT RELATED TO THE ILLINOIAN

It is scarcely necessary to discuss the suggestion that the Iowan may be correlated with the Illinoian. Parenthetically it may be said that if the Iowan and the Illinoian represent the same stage of glaciation, the name Illinoian becomes a synonym for Iowan, and we shall be reduced to the painful necessity of referring to one of our most beloved drift sheets as the "so-called Illinoian." But no such calamity awaits the Illinoian. The Iowan is much the younger of the two. As indicated by the structural and genetic relations above noted, the Iowan—a little later probably than its maximum stage—is practically contemporaneous with the loess; and as the Berlin paper, with noteworthy lucidity, correctly states on p. 299; "the Sangamon interval separates the loess from the Illinoian stage of glaciation so widely that there would seem to be no relation between loess deposition and Illinoian outwash." The same long interval, the same wide separation, exists between the Iowan and the Illinoian stages of glaciation. The two drifts are not related in time or in any other way. All the facts which may be gathered from the most thorough investigations in the field, support this last proposition:

The Iowan drift is not related to the Illinoian.